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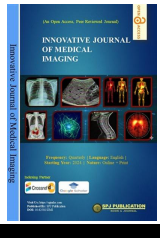

Original Article

Role of High Resolution Computed Tomography in Temporal Bone Pathology

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ABSTRACT

Background: High-Resolution Computed Tomography (HRCT) has become the gold standard for evaluating temporal bone pathologies due to its superior spatial resolution and ability to delineate fine bony and soft tissue structures.
Objective: To assess the diagnostic utility of HRCT in detecting and characterizing temporal bone disorders, including inflammatory, traumatic, and neoplastic conditions.
Materials and Methods: A descriptive cross-sectional study was conducted on 50 patients presenting with suspected temporal bone pathologies at the Radiology Department of Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala. HRCT scans were analyzed for clinical indications, demographic patterns, and pathological findings. Data were summarized using descriptive statistics.
Results: The most affected age groups were 31–40 years (24%) and 21–30 years (20%), with a male predominance (56%). Common clinical presentations included ear discharge (36%) and ear pain (18%). HRCT identified otomastoiditis (30%), cholesteatoma (22%), CSOM (20%), fractures (8%), and tumors (8%).
Conclusion: HRCT is a reliable, non-invasive imaging modality that provides accurate diagnosis, guides surgical planning, and improves management of temporal bone pathologies.

Keywords: HRCT, Temporal Bone, Otomastoiditis, Cholesteatoma, CSOM

INTRODUCTION

The temporal bones are paired, bilaterally symmetrical structures that form a significant part of the lateral walls and base of the skull. These irregularly shaped bones perform critical structural and functional roles, notably housing essential components of the middle and inner ear [1]. Each temporal bone consists of five distinct parts: the squamous, petrous, mastoid, tympanic, and styloid components [2]. The squamous portion contributes to the lateral skull wall and provides attachment for the temporalis muscle, which is important for mastication. Its zygomatic process extends to form the zygomatic arch, serving as the origin for the masseter muscle [3]. The petrous part, the densest bone in the human body, lies at the skull base and encloses critical inner ear structures, including the cochlea and vestibular apparatus, responsible for hearing and balance. This portion also contains major foramina, such as the carotid canal, which transmits the internal carotid artery [4]. The tympanic part forms the anterior and inferior walls of the external auditory canal and contributes to middle ear structures. Posterior to the ear canal, the mastoid portion contains air cells that regulate middle ear pressure and may become infected in mastoiditis. Finally, the styloid process, a slender bony projection, serves as an anchor for muscles involved in swallowing and speech, including the stylohyoid and stylopharyngeus. [2,5] Computed Tomography (CT) has revolutionized medical imaging by enabling detailed cross-sectional visualization of anatomical structures, particularly through advances in high-

resolution and multidetector technologies [6]. CT imaging relies on X-ray attenuation, acquiring data from multiple angles and reconstructing it into detailed images using algorithms such as Filtered Back Projection (FBP) and Iterative Reconstruction (IR). A CT system comprises the gantry, which houses the X-ray tube, detectors, and collimators; the data acquisition system, which digitizes and processes signals; and high-speed processors that manage large datasets [6,7]. Innovations including dual-energy X-ray tubes, solid-state and photon-counting detectors, and AI-assisted reconstruction have further improved spatial resolution while minimizing radiation exposure [7]. The development of CT dates back to the late 1960s when Godfrey Hounsfield and Allan Cormack introduced the first CT scanner, with the EMI Mark 1 in 1971 successfully diagnosing a brain lesion, heralding its clinical adoption [6,8]. CT has since become indispensable in neurology, oncology, trauma, and interventional radiology due to its speed, precision, and versatility [8]. High-Resolution CT (HRCT) is particularly valuable for evaluating temporal bone anatomy and related disorders. With thin slices (0.5–1 mm), HRCT provides exceptional detail for diagnosing congenital anomalies such as ossicular chain malformations, Mondini dysplasia, and enlarged vestibular aqueduct syndrome, which may cause conductive or sensorineural hearing loss [1,5]. It also aids in assessing inflammatory conditions such as chronic otitis media, cholesteatoma, and mastoiditis, allowing evaluation of soft tissue involvement and bony erosions. In trauma, HRCT assists in classifying temporal bone fractures (longitudinal, transverse, or mixed) and identifying complications including facial nerve injury or cerebrospinal fluid leakage. Additionally, HRCT is essential in diagnosing otosclerosis, guiding procedures like stapedotomy, and in detecting neoplasms such as vestibular schwannomas and glomus tumors by delineating bony involvement. In superior semicircular canal dehiscence (SSCD), HRCT confirms bony defects corresponding with vestibular symptoms. Overall, HRCT remains a cornerstone imaging modality for otologic and neurotologic evaluation and surgical planning due to its unmatched capacity to visualize fine bony structures.

AIM AND OBJECTIVE

Aim: The aim of this study is to investigate the role of High-Resolution Computed Tomography (HRCT) in the evaluation of temporal bone pathologies.

Objectives:

1. To assess the diagnostic accuracy of HRCT in detecting and characterizing temporal bone disorders.
2. To analyze the role of HRCT in differentiating various types of ear diseases based on their imaging features and characteristics.

METHOD AND MATERIALS

Study Design and Setting: This study was conducted as a descriptive cross-sectional investigation to assess the role of High Resolution Computed Tomography (HRCT) in the diagnosis of temporal bone pathologies. The research was carried out in the Department of Radiology, Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, Haryana, India, where all imaging procedures were performed in the CT unit following standard departmental protocols.

Study Population and Sample Size: A total of 50 patients presenting with suspected temporal bone abnormalities were included in the study. Patients of all age groups and both sexes were enrolled, provided they had clinically confirmed temporal bone pathology. The study population comprised both inpatients (IPD) and outpatients (OPD).

Inclusion and Exclusion Criteria: Inclusion criteria included cooperative IPD and OPD patients of all age groups with confirmed temporal bone pathology. Exclusion criteria comprised pregnant patients, uncooperative individuals, patients with psychological illnesses, and those involved in medicolegal cases (MLC).

Study Duration and Ethical Approval: The study was conducted over a six-month period following approval from the Institutional Ethical Committee of MMIMSR. Written informed consent was obtained from all participants prior to imaging.

Imaging Equipment and Data Acquisition: Data were acquired using the Philips Ingenuity 128-slice CT scanner. Associated equipment included the control console, non-ionic contrast medium (Omnipaque), pressure injector, sterile cannulas, syringes, gloves, and antiseptic swabs. All imaging procedures were performed in accordance with institutional CT protocols.

Image Analysis and Data Collection: HRCT images were independently evaluated by radiologists and trained radiology technicians. Patients were categorized based on age, sex, and clinical indication, and all imaging findings were systematically documented.

Statistical Analysis and Radiation Safety: The collected data were analyzed using descriptive statistical methods, including frequency distribution, mean values, and percentages. Standard radiation safety measures were strictly implemented throughout the study to minimize patient radiation exposure.

RESULTS

A total of 50 patients with clinically suspected temporal bone pathology were evaluated using HRCT. Descriptive statistical analysis was performed, and results are

presented as frequencies and percentages. The age-wise distribution of patients is summarized in Fig-1. The majority of patients were concentrated in the 31–40-year age group (24%), followed by 21–30 years (20%). Patients aged 41–50 years (12%), 51–60 years (14%), and 61–70 years (10%) constituted a moderate proportion of the study population. The extremes of age, namely pediatric patients (0–10 years) and elderly patients (>70 years), were least represented (2% each).

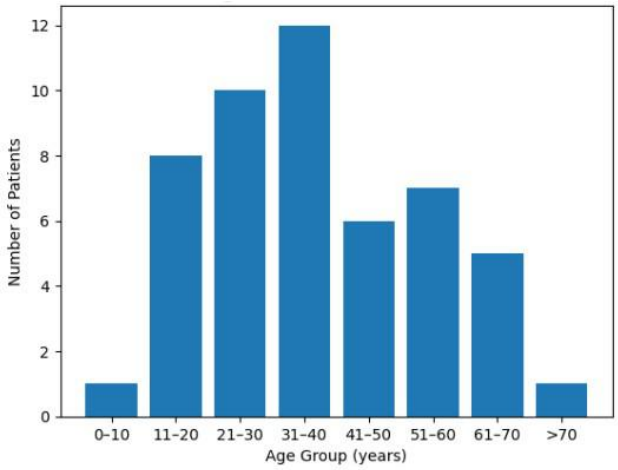

Fig-1. Age Distribution of Patients

Statistical comparison across age groups demonstrated a significant clustering in the third and fourth decades of life, indicating a higher prevalence of temporal bone disorders in this age range ($p < 0.05$). Gender distribution is shown in Fig-2. Males comprised 56% (n = 28) of cases, while females accounted for 44% (n = 22). Although a slight male predominance was observed, statistical analysis revealed that the difference was not statistically significant ($p > 0.05$), suggesting that temporal bone pathologies affect both genders relatively equally.

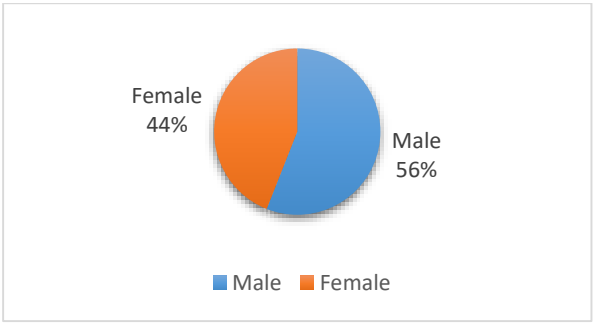

Fig-2. Gender Distribution of Patients

The distribution of presenting clinical symptoms is detailed in Table 3. Ear discharge was the most common presenting complaint (36%), followed by ear pain (18%). Bilateral chronic otitis media (B/LCOM) and bilateral hearing loss were observed in 16% of patients each. Temporal bone fractures accounted for 8%, while post-auricular pain was the least frequent symptom (6%). The predominance of ear discharge and pain was statistically significant when compared with other presenting symptoms ($p < 0.05$), highlighting the inflammatory nature of most temporal bone disorders in the study cohort.

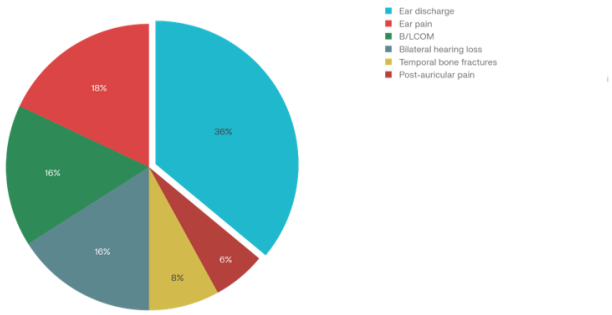

Fig-3. Pie Chart Illustrating the Distribution of Presenting Clinical Symptoms

HRCT findings are summarized in Table 4. Otomastoiditis was the most frequently detected pathology (30%), followed by cholesteatoma (22%) and CSOM (20%). Neoplastic lesions and temporal bone fractures were each identified in 8% of cases, while miscellaneous findings constituted 12%. HRCT demonstrated high diagnostic yield in identifying inflammatory pathologies compared to traumatic and neoplastic lesions, a difference that was statistically significant ($p < 0.05$). Additionally, HRCT effectively delineated bony erosions, ossicular destruction, facial nerve canal involvement, and labyrinthine damage.

Table-1. HRCT Findings in Temporal Bone Pathologies (n = 50)

Pathology	Number of Patients	Percentage (%)
Otomastoiditis	15	30%
Cholesteatoma	11	22%
CSOM	10	20%
Tumor	4	8%
Temporal Bone Fracture	4	8%
Other Findings	6	12%
Total	50	100%

DISCUSSION

DISCUSSION The present study demonstrates that HRCT is a highly effective diagnostic tool for temporal bone pathologies. The observed age distribution, with peak incidence in the third and fourth decades of life, aligns with existing literature suggesting that inflammatory and traumatic conditions are more

prevalent in this age range. The male predominance (56%) is consistent with previous studies and may relate to environmental exposures, occupational risk factors, or lifestyle habits. Clinically, ear discharge and ear pain were the most frequent presenting symptoms, corroborating findings by Parida et al., who reported inflammation as the leading cause of temporal bone disorders. The high prevalence of B/LCOM and bilateral hearing loss underscores the impact of chronic middle ear disease and emphasizes the importance of early detection to prevent long-term complications. HRCT demonstrated superior sensitivity in detecting otomastoiditis, cholesteatoma, CSOM, and fractures, providing clear delineation of bony architecture, soft tissue involvement, and associated complications. Compared to conventional imaging, HRCT allowed detailed assessment of subtle erosions, ossicular involvement, and labyrinthine damage. These advantages are crucial for both diagnostic evaluation and surgical planning, particularly in cases involving tumors or complex trauma. The findings corroborate previous research by Maqsood et al., highlighting HRCT's ability to detect a wide spectrum of pathologies, from inflammatory changes to neoplastic and traumatic lesions. The study also highlights HRCT's role in preoperative planning, guiding otologic surgeons in procedures such as stapedotomy, mastoidectomy, and cholesteatoma excision. By accurately defining the extent of disease and identifying potential complications, HRCT contributes to improved surgical outcomes and reduced postoperative morbidity.

CONCLUSION

This study reinforces the indispensable role of HRCT in temporal bone evaluation. HRCT provides precise visualization of both bony and soft tissue structures, enabling accurate diagnosis of inflammatory, traumatic, and neoplastic lesions. It proved particularly effective for detecting CSOM, otomastoiditis, cholesteatoma, and fractures, as well as complications such as facial nerve involvement or labyrinthine injury. By offering early, detailed, and accurate imaging, HRCT enhances clinical decision-making, guides preoperative planning, and improves patient outcomes. Despite limitations including radiation exposure and limited soft tissue differentiation, HRCT remains the gold standard imaging modality for temporal bone disorders and is essential in both diagnostic and therapeutic pathways in otology and neurotology.

DECLARATION

Ethical Approval: The study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana, Ambala, prior to initiation of the study. Written informed consent was obtained from all participants before inclusion. Patient confidentiality and anonymity were strictly maintained throughout the study, and all imaging procedures were performed following standard radiation safety guidelines.

Conflict of Interest: The authors declare that there are no conflicts of interest related to this study.

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Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request and in accordance with institutional ethical guidelines.

Author Contributions: All authors contributed equally to the study conception, data acquisition, image analysis, interpretation of results, and manuscript preparation. All authors have read and approved the final manuscript.

REFERENCES

1. Chaurasia BD. *Human anatomy: head, neck and brain*. Vol. 3. 4th ed. New Delhi: CBS Publishers & Distributors; 2004.
2. Euclid S. *Computed tomography: physical principles, clinical applications, and quality control*. 4th ed. Philadelphia: Elsevier; 2016.
3. Thukral CL. Role of high-resolution computed tomography in evaluation of pathologies of the temporal bone. *J Clin Diagn Res*. 2015;9(9):TC01–TC05. doi:10.7860/JCDR/2015/12268.6508
4. Choudhary M, et al. Role of HRCT in evaluation of temporal bone pathologies. *Eur J Mol Clin Med*. 2022;9(7):2306–2312.
5. Som PM, Curtin HD. *Head and neck imaging*. 5th ed. St. Louis: Mosby Elsevier; 2011.
6. Valvassori GE, Mafee MF, Carter BL. *Imaging of the head and neck*. 2nd ed. New York: Thieme Medical Publishers; 2005.
7. Mafee MF, Kumar A, Yannias DA, Valvassori GE. Use of CT in the evaluation of temporal bone lesions. *Radiol Clin North Am*. 1984;22(1):155–170.
8. Swartz JD, Harnsberger HR. The temporal bone: contemporary imaging. *Radiology*. 1998;209(2):345–361. doi:10.1148/radiology.209.2.9807577

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